# The Impact of Earthworms on Algae Population


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**Abstract**

Algae are eukaryotic organisms that are very important because they are at the base of most of their ecosystems' food webs and are, therefore, the initial sources of energy for herbivores all the way up the terrestrial food chain. Earthworms use algae as one of their principle sources of food and therefore, earthworms and algae participate in the soils' food web as one of the soil food chains. During the 2014 E.S.S.R.E. biota survey, it was determined that the algae level in the wettest of the four microclimates was unusually low. Given the extremely high earthworm population found in the same microclimate, we hypothesized that the predator-prey relationship between earthworms and algae was the primary source of these findings. Three locations were selected in each of the 4 microclimates and an implanted slide technique was used to test for algae levels. Simultaneously, an earthworm survey was conducted at each of the locations. We found that the relationship between algae and earthworms was inversely proportional as anticipated. But a statistical analysis showed only partial support for our hypothesis. We recommend further research on the relationship between algae density in the soil column and the amount of moisture in the surrounding soil.

## Introduction

Algae are eukaryotic organisms that have varying characteristics such as size and habitat. They are very important organisms because they are at the base of most of their ecosystems' food webs and are, therefore, the initial sources of energy for herbivores all the way up the terrestrial food chain ("Algae," 2009). Algae typically live in wet environments located both inside and outside of bodies of water. Those living outside of bodies of water are called terrestrial algae, as they are not dependent on a constant source of liquid water—though water is still essential for their survival (Graham, Graham, and Wilcox, 2009), providing algae with nutrients needed for their growth and the process of photosynthesis (Graham et al., 2009) which algae use to produce the necessary sugars and starches for times of drought ("Algae Basics," n.d.).

Similar to algae, earthworms are subterranean organisms, living in meadows, stream banks, and lawns that depend on water to survive. Earthworms breathe through their skin and therefore must remain moist to allow for the exchange of gases ("Earthworm," n.d.). Earthworms are important to the ecosystem because they ingest large amounts of soil, thus increasing soil nutrients and providing food for plants and other organisms ("Annelida," n.d.). One of their principle sources of food are algae ("Annelida," n.d.; "The Secret Life of Soil," n.d.) and therefore, earthworms and algae participate in the soils' food web as one of the soil food chains. Earthworms, as one of algae's predators, influence the algae population: an abundance of earthworms in a particular area can cause a corresponding decrease in algae levels.

During the E.S.S.R.E. 2014 biota survey, a significant anomaly was observed in microclimate Site 4. This site contains a partial wetland, making it ideal for both algae and earthworm populations. But Site 4 contained unexpectedly and statistically significantly lower levels of algae (0.43 $mm^2$) than the much drier Site 2 (8.26 $mm^2$), which we found puzzling. However, an examination of the earthworm densities observed this year (Site 4: 212 $m^2$; Site 2: 54 $m^2$ ) led us to investigate the correlation between low levels of algae and high numbers of earthworms to determine if the traditional predator/prey relationship was the source of the low algae levels in Site 4.

## Methods

In E.S.S.R.E. Sites 1, 2, 3, and 4 (E.S.S.R.E., 2001), 3 separate 15cm by 15cm plots were marked in each site and 5 standard glass microscope slides were implanted 6cm into the soil within each plot (Pipe and Cullimore, 1980). After 48 hours, the implanted slides were retrieved. Each algae slide was rinsed gently with distilled water to remove excess dirt and placed between two clean microscope slides for viewing purposes.

Immediately following the removal of the microscope slides, the top 15cm of soil was extracted from each plot to survey for earthworms. The extracted soil was sifted by hand and the number of earthworms in each plot was counted and recorded. The implanted slides were then examined using a light microscope at 40x. Five separate fields of view were examined and the numbers of algae present were recorded. The 5 fields of view counted were averaged and divided by 17.3 to determine the number of algae per square millimeter in the column of soil.

**Results**

Figure 1

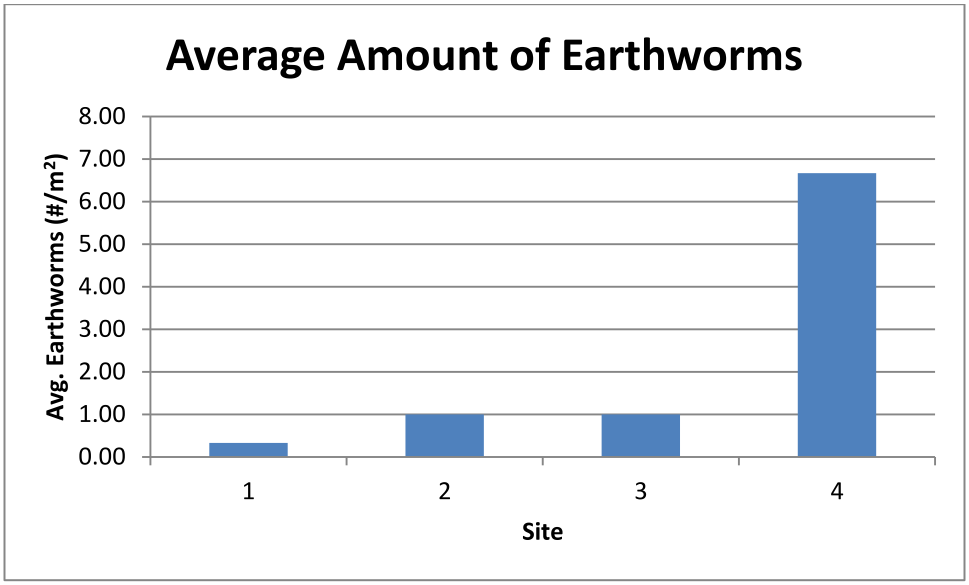


Figure 1 represents the correlation between the density of earthworms (#/$m^2$) and the location in which they were observed.

Figure 2

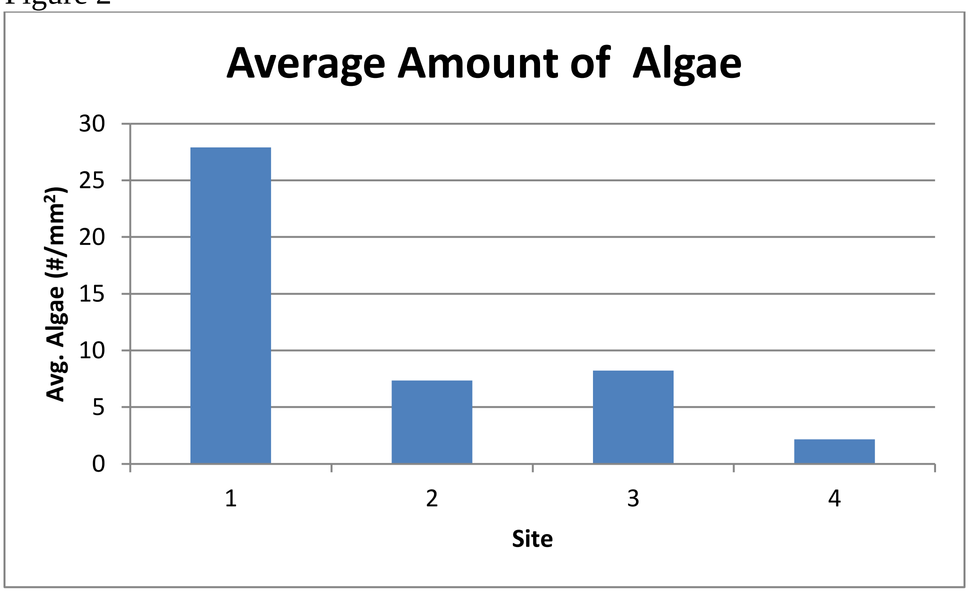


Figure 2 represents the correlation between the density of algae (#/$mm^2$) and the location in which they were observed.

Figure 3

The Effect of Earthworm numbers on Algae Levels.

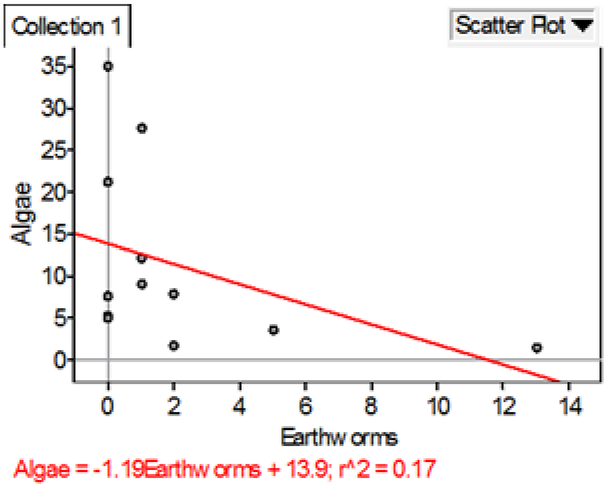


Figure 3 shows the numbers of earthworms related to the levels of algae found after data collection.

Figure 4

| Earthworm T-test Results | |
|---|---|
| Sites | P-values |
| 1 & 2 | 0.39 |
| 1 & 3 | 0.39 |
| 1 & 4 | 0.19 |
| 2 & 3 | 1 |
| 2 & 4 | 0.22 |
| 3 & 4 | 0.22 |

Figure 5

| Algae T-Test Results | |
|---|---|
| Sites | P-values |
| 1 & 2 | 0.000000078 |
| 1 & 3 | 0.00000009 |
| 1 & 4 | 9.10E-09 |
| 2 & 3 | 0.54 |
| 2 & 4 | 0.000006 |
| 3 & 4 | 0.000083 |

**Discussion**

As shown in Figure 1, the earthworm population remained consistently greater in Site 4 than Sites 1, 2, or 3 during the course of the experiment, indicating that the conditions observed in the original biota survey remained stable through the testing period. Figure 2, conversely, demonstrates that the amount of algae in Site 4 remained notably small as well. Hence, whatever the source of the original statistical anomaly (E.S.S.R.E., 2014), that source likely was present throughout the 6 days of the experimental period.

Therefore, the pattern observed in Figure 3 would seem to support our original hypothesis by exhibiting the anticipated inverse relationship between earthworms and algae (i.e. where there are more earthworms present, there are fewer algae found). However, while Figure 3 provides partial support for the hypothesis, it also demonstrates that earthworms are not the primary cause of the algae depletion originally seen in the original biota survey (E.S.S.R.E., 2014). A linear regression analysis of our data revealed an $r^2$ value of 0.17. Hence, only 17% of the observed decline in algae can be attributed to earthworm consumption.

A t-test of the earthworm data in each site supports the conclusion that the earthworms are not the main reason for the regression in algae. As the p-values in Figure 4 indicate, there was no statistically significant difference in earthworm quantities in the different research sites. Since the earthworms are not notably different, it is even less likely for them to be the primary cause of the differences in the algae count.

Yet there is clearly a significant difference in algae levels across all sites as the p-values in Figure 5 indicate. Hence, there must be something in the research sites that is producing the change in the algae levels we observed. One possible source might be the differences in the amount of water present in the different experimental plots, since water is the most important resource for algae survival. In further research, we would test the soil where the algae slides were planted for the moisture levels. Perhaps low moisture levels in Site 4 or high moisture levels in Sites 1, 2, and 3 are the answer.

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